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Attitudes of Maintenance Personnel Towards Maintenance Work: A Comparative Analysis

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SUMMARY

Previous IS research has shown that problems related to maintenance staffing (as distinct, for example, from technological problems) are among the more important problems in software maintenance. In particular, the attitudes of maintenance personnel toward their work can have adverse effects on their performance and the quality of the application portfolios they help to sustain. This paper reports on a study of Singapore maintenance personnel who are actively involved in maintaining application systems, or who directly supervise the maintenance process. These 'maintainer' views are compared with the views of maintenance managers. The results are also compared against findings from prior studies conducted in the USA. © 1998 John Wiley & Sons, Ltd.

KEY WORDS: maintenance personnel; personnel attitudes; cross–cultural research; personnel motivation; personnel morale; maintenance problems

1. INTRODUCTION

Software maintenance is defined as all changes performed on operational application systems to correct faults, to adapt to a changed environment or to improve performance or other attributes (IEEE, 1993). These changes are necessary and crucial as they ensure that the application systems which support the organization's key business processes remain consistent with internal and external conditions. Nevertheless, despite the fact that software maintenance is now better researched and understood than ever before, it has never received the attention accorded software development nor its due regard, in the view of the authors.

Several key studies in the past have rendered valuable insights into problems of managing software maintenance. Researchers like Lientz and Swanson (1980), Martin and

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Osborne (1983), Chapin (1985), Swanson and Beath (1989), Dekleva (1992) and more recently, Dart, Christie and Brown (1993), and Tan and Gable (1997) have shown that these maintenance problems have both technological and non–technological bases. Several of these studies further suggest that issues associated with maintenance staffing are as important as issues associated with maintenance activities, maintenance tools and techniques, and user or senior management support.

This paper reports on an investigation of the attitudes of Singapore maintenance personnel towards maintenance work. The paper also compares the findings of the study against results of earlier research involving Singapore maintenance managers and also against data from several studies from the United States.

2. INVESTIGATION APPROACH

The investigation was carried out among attendees at several runnings of a software maintenance course in 1995 and 1996 conducted by the Institute of Systems Science, a training institute that provides continuing information technology (IT) education for practising computer professionals in Singapore. A one–page questionnaire, which was adapted from that used in Dekleva's (1992) Software Maintenance Association (SMA) survey, was distributed to selected attendees at the start of each course. These attendees had job titles like analyst programmer, systems analyst and software engineer, which suggests that they were directly involved in the maintenance activity.

Part one of the four–part questionnaire contains general questions about the respondent's organization. Part two queries how maintenance personnel are organized in the IS department. Part three explores the relative opportunities offered by, and the relative demands required of, software maintenance versus software development. Part four is based on two open–ended questions inviting respondents to state three major maintenance problems and three maintenance changes they would like to see implemented in their organizations. Dekleva's format was adopted to facilitate comparison with his North American results. 47 valid responses were gathered over several runs of the course.

The responses to the first three parts of the questionnaire were tallied manually and the tallies entered into a spreadsheet to facilitate tabulation, summarization and analysis. The responses to the fourth part of the questionnaire were manually categorized, and the resulting tallies within each category were then transferred into the spreadsheet.

After producing summary counts, statistical analyses were run. For selected portions of the data, these included arithmetic means, standard deviations, analysis of variance, correlation, and tests of significance including binomial tests and 't' tests. In addition, some comparisons were made of the study's data with data reported from other sources, as described in Section 3.

3. RESULTS

3.1. Background of the respondents

As shown in Table 1, about three–quarters of the respondents are maintenance programmers while the rest are project leaders who direct the maintenance team. About two–

Table 1. Respondent demographics ($N = 47$)

Characteristic	Frequency	Per cent
Respondent's role		
Maintenance programmer	34	72
Team leader	13	28
	47	100
Industry type		
Financial services	3	6
Government	18	38
Transportation	12	26
Utility/telecommunication	4	9
Computer-related	9	19
Healthcare	1	2
	47	100
Number of IS employees		
<20	8	18
21 to 40	8	18
41 to 60	6	14
61 to 80	3	7
81 to 100	0	0
>100	19	43
	44*	100
Installation type		
Mainframe	31	66
Minicomputer	16	34
	47	100

*Did not add up to 47 due to missing data.

thirds are from the private sector, and about one–third are from various government organizations. The majority of the respondents were from mainframe installations, and about three–sevenths come from organizations with more than 100 information systems (IS) employees.

3.2. Organization of software maintenance

Table 2 shows how respondents described the organization of software maintenance in their IS function. 66 per cent of respondents reported that maintenance and development

Table 2. Software maintenance organization

Characteristic	Frequency	Per cent
Separate groups, each group has its own manager	31	66
Same group but separate assignments	14	30
Rotating assignments	5	11
Simultaneous development and maintenance	29	62

are organized into separate groups, each having its own manager. 30 per cent indicated that the IS personnel in their companies are assigned either to development or to maintenance but within the same group. 11 per cent of respondents belong to organizations that practise staff rotation between the two functions, while 62 per cent stated that IS personnel develop and maintain application systems at the same time.

3.3. Morale and skills issues

Table 3 summarizes the respondents' answers to various measures of morale and to skills issues. The results are further compared with those obtained by Dekleva (1992) in his 1990 SMA survey. It is noted that both studies concentrated on personnel who actively maintain application systems or who directly supervise the maintenance process.

In all of the seven opportunity measures, except responsibility offered, respondents indicated that development offers greater opportunity than maintenance, thus suggesting that Singapore maintainers view maintenance as being relatively undesirable. In contrast, Dekleva reported that respondents indicated development offers greater opportunity in only three of the seven measures. Furthermore, the majority of Singapore maintainers, unlike their US counterparts (Dekleva, 1992), find maintenance offering less responsibility and challenge than development. While US maintainers feel that both jobs are paid about the same (71%), Singapore maintainers are less inclined to share this sentiment (53%).

Table 3. Opportunities and demands from software maintenance: Singapore versus United States

	Tan and Gable (1997) data ($N = 47$)			Dekleva (1992) data ($N = 59$)		
Offers and demands	Maintenance (%)	Development (%)	Same (%)	Maintenance (%)	Development (%)	Same (%)
Opportunities: which offers more						
Responsibility	30**	19**	51**	76**	2**	22**
Personal satisfaction	0**	89**	11**	40**	28**	33**
Challenge	6**	68**	26	66**	9**	26
Learning opportunity	11**	68**	21	40**	33**	28
Career growth	4	77**	19	12	59**	29
Exposure to management	4**	68	28	17**	62	21
Salary	2	45**	53**	3	26**	71**
Average	8**	62**	30	36**	31**	33
Demands: which demands more						
Experience	36**	30**	34**	78**	14**	9**
Ability to interact with people	15**	38**	47**	71**	5**	24**
Problem-solving skills	55**	11**	34**	88**	0**	12**
Programming skills	21**	34**	45	48**	10**	41
Design skills	0**	77**	23	17**	55**	28
Knowledge of user business	15**	23**	62	38**	12**	50
Intuition	26**	19**	55**	78**	3**	19**
Average	24**	33**	43**	60**	14**	26**

Note: **indicates significant at the 0·01 level or better.

Furthermore, while maintainers in both countries share the common notion that development offers more in terms of career growth and exposure to management, Singaporeans are more emphatic about the relative lack of these opportunities.

On demands overall, Singapore respondents perceive little difference in the capability demands of maintenance versus development (24% versus 33%). In contrast, Dekleva's study shows that US maintainers view maintenance as being more demanding than development (60% versus 14%) especially in terms of experience, ability to interact, problem–solving skills and intuition. Both Singapore and US respondents tend to regard design skills as more critical in new systems development than in maintenance and this conviction appears significantly stronger in the Singapore case. While the majority of both (62% and 50%) believe that maintenance and development require knowledge of the user business, the Singapore respondents report significantly less demand.

Using binomial testing, the Singapore scores were compared with those from the Dekleva study. From Table 3 it is observed that of the 42 measures (ignoring overall averages), only 10 are not significantly different at the one per cent level. Of the 14 measures, approximately one-third of Singaporean respondents indicate the view that maintenance requires greater (1) responsibility, (2) experience, (3) problem–solving skills and (4) intuition. Singaporeans view development to be relatively more demanding or offering more than maintenance on the other 10 measures.

The US study yielded quite contrary results, finding maintenance to be relatively more demanding or rewarding on 10 of the 14 measures, including the four noted for the Singapore maintainers. This left four measures (career growth, exposure to management, salary and design skills), and on all four, Singaporeans hold the view that maintenance offers or demands less than did the US respondents, and sometimes significantly so. Especially telling is the fact that in the US study, 73% of respondents scored maintenance as offering more or the same 'personal satisfaction', while in Singapore no respondents (0%) indicated that maintenance was more satisfying and only 11% indicated it to be equally satisfying as development.

Broadly, these data support the general observation that Singapore maintainers are relatively less positive regarding maintenance as compared with their US counterparts.

3.4. Problems experienced and change desired

Table 4 summarizes the 121 responses (averaging 2·6 statements per respondent) to the open–ended prompt: 'What are the three major software maintenance problems in your IS department?' As the responses vary widely, they were first condensed into logical groupings and the results later used to populate the empirical problem categories that were first used by Chapin (1985) and later adopted by Dekleva (1992) in his SMA annual survey: (1) maintenance management, (2) systems characteristics, (3) personnel factors, (4) user relations and (5) environmental factors. It is found that the largest number of the problems reported (38%) are attributed to maintenance management or the management of the maintenance process. Problems relating to the application software (labelled here as system characteristics) and personnel factors, constitute 31% and 17% of the responses, respectively. Interestingly, user problems are not as commonly viewed

Table 4. Categories of problems experienced

Problems experienced	Frequency	Per cent	
Maintenance management			
Maintenance standards	8	6·6	
Maintenance tools	7	5·8	
Meeting scheduled commitments	7	5·8	
User change procedures	6	5·0	
Configuration management	6	5·0	
Release controls	3	2·4	
Testing procedures	2	1·7	
Change cost justification	2	1·7	
Program change controls	2	1·7	
Budgetary pressures	2	1·7	
Maintenance measurement	1	0·8	38·2
System characteristics			
Quality of documentation	19	15·6	
Unstructured programs	6	5·0	
Ageing systems	5	4·1	
Quality of original programming	3	2·4	
Adequacy of application design specification	3	2·5	
Storage requirements of programs	1	0·8	
Application software run failures	1	0·8	31·2
Personnel factors			
Skills of maintenance personnel	6	5·0	
Number of maintenance personnel available	6	5·0	
Turnover of maintenance personnel	4	3·3	
Motivation of maintenance personnel	4	3·3	16·6
User relations			
User demand for enhancement	5	4·1	
Management support	5	4·1	
Lack of user understanding	2	1·7	
Unrealistic user expectations	1	0·8	10·7
Environmental factors			
Dynamic business change	4	3·3	3·3
	$N = 121$	100·0	100·0

as major (11%), while problems associated with environmental factors get even less frequent mention.

Table 5, which was derived in the same manner as Table 4, summarizes the 102 responses (averaging 2·2 statements per respondent) to the question: 'If you could change three things about software maintenance in your IS department, what would they be?' Not unexpectedly, the results in Table 5 mirror those in Table 4, although there are some

Table 5. Categories of changes desired

Changes desired	Frequency	Per cent	
Maintenance management			
Maintenance tools	12	11·8	
Maintenance standards	11	10·8	
Configuration management	9	8·8	
User change procedures	5	4·8	
Maintenance measurement	4	3·9	
Change cost justification	2	2·0	
Release controls	2	2·0	
Maintenance organization	2	2·0	
Outsourcing of maintenance	2	2·0	
Maintenance techniques	1	1·0	
Scheduling of personnel time	1	1·0	50·1
System characteristics			
Quality of documentation	12	11·8	
Program maintainability	5	4·8	
Revamp of hard-to-maintain systems	4	3·9	
Application software run failures	3	2·9	
Storage requirements of programs	1	1·0	
Quality of original programming	1	1·0	
Adequacy of application design specification	1	1·0	26·4
Personnel factors			
Skills of maintenance personnel	6	5·9	
Number of maintenance personnel	4	3·9	
Motivation of maintenance personnel	3	2·9	
Turnover of maintenance personnel	1	1·0	13·7
User relations			
User interest	4	3·9	
User training	3	2·9	
Management support	2	2·0	
Report enhancement done by user	1	1·0	9·8
	$N = 102$	100·0	100·0

differences in the percentage distributions, with none of the differences being significant. Respondents expressed a stronger desire for changes to maintenance management (50% versus. 38%). Calls by respondents for improvements to system characteristics (26%), personnel factors (14%) and user relations (10%) are of about the same magnitude as in Table 4.

Table 6 compares the Singapore results with the Dekleva (1992) and Chapin (1985) findings, and notes the significant differences between the three studies (the Chapin data did not include the changes desired). It is observed that the Singapore and Dekleva data exhibit similar patterns. That is, the order of concern is: maintenance management, system

Table 6. Comparison of Singapore results with Dekleva (1992) and Chapin (1985) studies

Problem categories	Tan and Gable (1997) data		Dekleva (1992) data		Chapin (1984) data
	Problems experienced (%)	Changes desired (%)	Problems experienced (%)	Changes desired (%)	Problems experienced (%)
Maintenance management	38**	50	28**	49	9**
System characteristics	31**	26**	21**	15**	48**
Personnel factors	17	14	19	18	19
User relations	11**	10**	5**	3**	5**
Environmental factors	3**	0**	19**	14**	8*
Maintenance activities	0	0	4	0	7
Miscellaneous	0	0	4	1	0

Notes: *significant at the 0·05 level; **significant at the 0·01 level.

characteristics, personnel factors and user relations. However, the Singapore respondents report significantly more problems in maintenance management, system characteristics and user relations than the Dekleva respondents. The Singapore respondents also report signficantly more change desired in system characteristics and user relations than the Dekleva respondents. These two sets of results, however, contrast with Chapin's earlier results which highlighted problems with the application software.

3.5. Comparison of maintenance personnel and maintenance manager perceptions

In an earlier study, Tan and Gable (1997) surveyed Singapore maintenance managers in 1992 using a modified version of Lientz and Swanson's (1980) original instrument and their predefined 26 problems. These maintenance problems were evaluated on a five–point Likert–like scale in which one represents 'no problem' and five 'major problem'. Table 7 reports results of grouping the resultant 26 problem scores into Chapin's problem categories. The same table also lists the corresponding Lientz and Swanson results and those of Nosek and Palvia (1990) who conducted a follow–on (quasi–longitudinal) study employing the same research instrument and population sampled from (DPMA members) as Lientz and Swanson.

From the category scores, personnel factors are found to emerge at the top of the maintenance managers' list of issues (category average score = 3·12). In contrast, Table 4 indicated that the chief concern of maintainers is poor management of the maintenance effort. It thus appears that Singapore maintenance personnel and managers are faulting each other for the woes they are each experiencing. Further analysis of the two tables reveals that while the maintainers see application software as the second major contributor to the maintenance problem, maintenance managers are less inclined to hold this opinion. Both groups, however, consider user relations as an issue warranting relatively less attention.

It can further be seen from Table 7 that, unlike their Singapore counterparts, North

Table 7. Comparison of Singapore and North America problem areas[1]

Problems	Tan and Gable (1997) data			Lientz and Swanson (1980) data			Nosek and Palvia (1990) data[3]	
	Rank	Mean[2]	Std dev	Rank	Mean	Std dev	Rank	Mean
Personnel factors								
Number of maintenance programmers available	4	3·27**	1·09	8	2·58	1·33	7	2·65
Maintenance personnel turnover	7	3·23**	1·24	14	2·23	1·34	13	2·41
Skills of maintenance personnel	9	3·06**	1·07	16	2·08	1·16	18	2·19
Maintenance programmer motivation	12	2·92**	1·09	21	1·92	1·11	19	2·10
Overall rank and average score for factor =	*1*	*3·12*	*0·61*	*4*	*2·20***	*0·28*	*3*	*2·34***
Maintenance management								
Competing demands for programmer time	2	3·43**	1·08	2	3·03	1·34	2	3·17
Meeting scheduled commitments	3	3·40**	0·99	5	2·69	1·24	6	2·65
Maintenance programming productivity	14	2·85**	0·92	17	2·04	1·09	16	2·25
Forecasting maintenance programmer requirements	16	2·76*	0·95	11	2·46	1·22	11	2·56
Budgetary pressures	17	2·71**	1·11	19	1·98	1·21	17	2·25
Adherence to programming standards	18	2·70**	0·93	15	2·11	1·09	15	2·25
Overall rank and average score for factor =	*2*	*2·98*	*0·35*	*2*	*2·39**	*0·42*	*1*	*2·52*
User relations								
User demand for enhancements	1	3·66**	1·00	1	3·20	1·17	1	3·29
Unrealistic user expectations	6	3·26**	1·08	9	2·55	1·26	4	2·81
Turnover in user organization	10	3·00**	1·13	13	2·36	1·24	14	2·39
Lack of user understanding	13	2·90*	1·10	6	2·61	1·27	8	2·62
Inadequate user training	15	2·82	1·03	4	2·76	1·24	9	2·60
Lack of user interest	21	2·39**	1·14	23	1·87	1·22	24	1·83
Management support	23	2·29**	1·07	25	1·85	1·11	23	1·90
Overall rank and average score for factor =	*3*	*2·90*	*0·48*	*1*	*2·46*	*0·48*	*2*	*2·49*

Table 7 continued overleaf

Table 7. *Continued*

Problems	Tan and Gable (1997) data Rank	Mean[2]	Std dev	Lientz and Swanson (1980) data Rank	Mean	Std dev	Nosek and Palvia (1990) data[3] Rank	Mean
System characteristics								
Documentation quality	5	3·26	0·84	3	3·00	1·31	3	3·17
Quality of original programming	8	3·21**	1·02	7	2·59	1·33	10	2·58
Adequacy of system design specification	11	2·98**	0·93	12	2·43	1·26	5	2·77
Program processing time requirements	19	2·64	1·07	10	2·55	1·26	12	2·42
Data integrity in application software	20	2·58**	0·98	22	1·90	1·08	21	1·96
Application software run failures	22	2·37**	1·01	24	1·87	0·97	25	1·82
System hardware and software changes	24	2·17	0·97	18	2·04	1·17	20	2·06
Hardware and software reliability	25	1·99	0·97	26	1·81	1·04	26	1·77
Program storage requirements	26	1·89	0·93	20	1·98	1·22	22	1·92
Overall rank and average score for factor =	*4*	*2·57*	*0·51*	*3*	*2·24*	*0·41*	*4*	*2·27*

Notes: [1]Adapted from Tan and Gable (1997) using Lientz and Swanson's five-point rating scale ranging from 1 = 'no problem at all' to 5 = 'major problem'.
[2]The significance of differences of the Tan and Gable data with the Lientz and Swanson data are indicated as $*p < 0{\cdot}05$; $**p < 0{\cdot}01$.
[3]Standard deviations are not available with Nosek and Palvia data; the significance of differences of the averages of these and of the Lientz and Swanson data with the Tan and Gable data are indicated as $*p < 0{\cdot}05$ and $**p < 0{\cdot}01$.

American maintenance managers are less concerned with personnel factors but more with their relations with the user. All three studies suggest that maintenance managers in both Singapore and North America share a common view of the difficulties managing and scheduling maintenance work. In addition, both North American and Singapore maintenance managers rate application software quality as a relatively less important factor.

Table 7 also shows that Singapore respondents have assigned higher scores to 25 of the 26 maintenance problems. The correlation between the Singapore and the Lientz and Swanson data is +0·77, and between the Singapore and the Nosek and Palvia data is +0·84 (between the Lientz and Swanson and the Nosek and Palvia data the correlation is +0·96). All three correlations are significantly larger than zero at the one per cent level, but the two correlations involving the Singapore scores are not significantly different from each other. This suggests some source of variation accounting for at least 59% of the variation between the Singapore and the other data. An analysis of variance reveals only that the Singapore scores are significantly higher ($p < 0{\cdot}05$) than the Lientz and Swanson (1980) data for 20 of the 26 problems. The samples were not deemed large enough to warrant a factor analysis. Thus, the Singapore scores appear systematically higher than the North American scores but in step with them—i.e., in Singapore, managers see significantly more of mostly the same problems. The authors in Tan and Gable (1997)

attributed this trend to the culturally–based psychometric differences between Singapore and North America respondents' perceptions about and marking of questionnaire scales.

4. DISCUSSION OF FINDINGS

The study results suggest that Singapore maintenance personnel have a more adverse view of maintenance than their US colleagues. In particular, Singapore maintenance personnel find their jobs neither challenging nor responsible. They also believe that their development colleagues are better paid and have better promotion prospects. These findings reinforce results from Couger's 1985 cross–cultural study (Couger, 1989) which compared the motivation of Singapore analysts and programmers against that of their North American counterparts. As part of national planning, the then Singapore National Computer Board contracted with Couger–Zawacki and Associates to conduct a comprehensive study of software capabilities. Couger observed that Singaporean analysts perceived their jobs to be less challenging than did their US counterparts and that maintenance work was seen to be highly undesirable in both settings.

Reports of such negative views of the maintenance task abound in the literature. Couger and Colter's extensive survey (Couger and Colter, 1985) among 500 persons in 10 organizations, and later on–site interviews with 104 analysts, programmers and managers, attested to this notion. Martin and Osborne (1983), who based their work on selected US Federal agencies and private sector organizations, also noted the common complaint by maintenance personnel that software maintenance is unimportant, unchallenging, unrewarding, uncreative work which is seldom appreciated. Layzell and Macaulay (1994) found from their study of five major companies in the United Kingdom that some organizations had 'difficulty in recruiting younger staff to the maintenance function'. A recent study by Dart, Christie and Brown (1993, p. 38) at an unspecified US government agency also revealed that maintenance is not treated as a prestigious job but that those who choose to carry out maintenance see it as a 'most challenging task'.

The low prestige that Singapore maintenance personnel attach to maintenance is among other undesirable IS personnel issues that flow from the rapid pace of computerization in Singapore. Several Singapore studies have previously investigated these issues. Tan and Igbaria (1994) argue that high turnover among Singapore computer professionals is due to competition from employers who offer higher remuneration, and to perceived limited advancement opportunities. Chan and Woo (1995) observe that challenging work, greater autonomy, improved career opportunities and better pay are some of the goals that IS and other professionals work towards. In the case of computer professionals, such inducements are even more necessary. Singapore computer professionals are highly mobile due to demand exceeding supply. Thus, better pay and advancement opportunities in system development work appear to promote job change. Pushing to move into management exacerbates the situation. Loh, Sankar and Yeong (1995) found that the level of job satisfaction decreases when technically–orientated Singapore IS professionals, believing that there are better rewards and prospects in managerial positions, aspire to move into management sooner than they are ready.

Another plausible reason for the low status accorded in Singapore to maintenance is the adoption of inappropriate IS personnel practices, thus denying maintainers what Couger

and Colter (1985, p. 8) refer to as 'meaningfulness in the work'. In a companion study (Tan and Gable, 1997), the authors found that Singapore IS organizations tend to treat maintenance as a training ground, and mistakenly assign new personnel to the function. Such action can only wrongly signal to these staff that maintenance is an insignificant task; one that can be safely allocated to newcomers. In the current study, several respondents complained that their IS departments do not practise enough job rotation and that this deprived them of opportunities to exercise their different skills and talents. Still other respondents indicated they were asked to simultaneously develop new systems and maintain existing ones, the result being that the maintainers are unable to experience the completion of a 'whole and identifiable piece of work' (Couger and Colter, 1985, p. 8). Needless to say, all these practices have demoralizing effects on the maintenance personnel and cause them to take a low view of their job.

Interestingly too, the current study indicates that Singapore maintainers do not seem to share the same belief as their US counterparts that maintenance requires more skill than does development. One of the commonly held notions among maintenance researchers is that maintenance requires more skills than development because maintainers have to work within many constraints, such as the limitations of existing code (Chapin, 1987). This appears to be less the perception in Singapore. A possible explanation is the relative youthfulness of the typical application portfolio in Singapore as compared with those in the US (Tan and Gable, 1997). Young application software tends to require less effort to modify as the programs have not yet deteriorated through structural degradation and prolonged patching. In the same study by the authors, it was also observed that a large number of the application portfolios surveyed were based on fourth–generation programming languages (4GLs). 4GLs, according to Martin and McClure (1983), promote maintenance productivity as they simplify code modification, although Chapin (1984) has reported contrary experience. Other explanations can be found in the 1995 manpower and skills inventory survey report by the Singapore National Computer Board (1995, p. 28). That report, based on 4 192 responses, noted that Singapore IS professionals generally possess proficient structured analysis and design skills. It could be inferred that this proficiency enables Singapore software developers to produce applications that are more conducive to future change.

The other intriguing finding from the current study is the contrasting views of maintenance personnel and maintenance managers regarding the relative importance of the problem areas. While maintainers perceive that the managers have not or have inadequately implemented suitable maintenance processes to facilitate their work, the managers, on the other hand, singled out maintenance personnel issues as their main obstacle to achievement of their goals. The managers also alluded to concerns with the attitude of senior management towards maintenance (as manifested in their comments about inadequate maintenance personnel resources). It could be argued that both maintenance personnel and managers are actually looking at a common issue but from two different perspectives. That is, that rapid computerization in Singapore has drawn many IS resources away from maintenance to development. With senior management and user preoccupation with new development, usually in the name of strategic advantage, Singapore IS managers are unlikely to pay much attention to maintenance. This is borne out in the level of attendance at the Institute of Systems Science where courses providing skills in developing new

applications are highly popular while those supporting maintenance see much lower demand.

Fast–paced computerization has given rise to intense competition among IS organizations for technical personnel, which has in turn resulted in substantial and perennial staff turnover, the bane of Singapore IS managers. This is a common observation among the various Singapore studies (e.g., Tan and Igbaria (1994)). The shortage of computer personnel is so acute that the recent study by Singapore National Computer Board (1995, p. 25) reported a growing need in several sectors to consider outsourcing to fulfil their IS manpower requirements. Besides this option, Singapore IS managers have also looked to new college graduates to redress the shortage. The approach of hiring inexperienced though technically competent personnel has the drawback that these new entrants generally lack the business knowledge and skills to undertake maintenance effectively (Chapin, 1987). Moreover, being young, these new hires have high expectations of career prospects and rewards. Combined with the shortage of staff, the low experience level of new staff, the impatience of IS personnel to advance, and the low status of maintenance work, Singapore IS managers find the upkeep of their application portfolios a grueling task.

Maintenance managers must somehow convince senior management of the severity of the problem and the need for further maintenance resources. In an era of rightsizing and outsourcing, there may be reluctance to push this barrow too strenuously. The millenium (Year 2000) problem has helped to increase awareness of the software maintenance situation, but has perhaps too often resulted in a 'knee–jerk' reaction from senior management to outsource or to replace legacy applications with packaged solutions, the consequence often being decreased IS functionality and decreased responsiveness to organizational needs.

5. DISCUSSION OF ACTION ALTERNATIVES

5.1. IS personnel practices

The results of our study depict situations about which IS management may want to take action. Managers need to focus more on creating a career path for their maintenance staff, or on offering compensating stimulation, rewards and security. What is required is a generally increased emphasis on people management issues in software maintenance management—a relatively greater emphasis than with development staff. There is a need to be proactive regarding the image of maintenance within the organization. Managers should be alert to opportunities for promoting the importance of maintenance and for changing the mindset of senior management. Development projects can be halted or even 'killed' in flight with little or no detrimental effect on the company's bottom line. However, typically, the company's operations require a 'show must go on' attitude, and hence important software modifications must be undertaken and carried to a functionally adequate completion, if the company is to remain viable.

5.2. Organization of maintenance function

Swanson and Beath (1989) provided several useful ideas on 'building the maintenance staff': avoid using maintenance as a training ground, assign new people to systems of lesser strategic importance, provide ongoing classroom training in the application systems portfolio, use job rotation, and monitor 'staff demographics' for diagnosing problems of organizational fit. Management should also consider making individuals/teams responsible for the development and ongoing maintenance (including enhancement) of a 'whole' system, and seek to encourage a sense of 'ownership' and responsibility for the system. New staff should not be assigned to maintenance in such teams except perhaps in some sort of a 'buddy' system.

A Gartner report (Shipley, 1995) suggests that maintenance should report to IS operations since both groups share common goals: 'keep it up, safe and cheap'. The report notes that operations organizations work with existing systems, using familiar installed technologies. They work as needed, sometimes under extreme time pressure and at odd hours. Although they work sometimes with high visibility, often their work when successful goes unnoticed. Software maintenance personnel may become valued members of and enjoy improved morale in an operations community that shares their values.

Alternatively, maintenance could be outsourced. Outsourcing of computer operations and facilities management is today being seriously contemplated by many organizations. Perhaps another argument for outsourcing is that operations, and hardware and software maintenance, are core activities of the outsourcer. One would thus expect that these activities will have greater importance or status within the outsourcing organization (just as audit is a core function to 'big 4' auditing firms).

In our observation, maintenance, as compared with new systems development, tends to require less interaction with users and the organization. On this basis, maintenance may lend itself to telecommuting. It may thus prove beneficial to 'outsource' or 'contract' maintenance work to IS professionals who would otherwise chose to quit their 'go–to–the–office' jobs in order to stay home and raise their families.

5.3. At the macro level

Another alternative is to explore the potential for organizing operations and maintenance managers to promote the idea of a separate software maintenance profession, along the lines of computer audit. Given the existence of such an association, managers could encourage their maintenance staff to join and be involved. Such a 'profession' may be able to offer much of what the job cannot.

Development and maintenance tasks require different skill sets (Chapin, 1987). The job of maintenance personnel is heavily constrained by the existing code. Current college curricula should be changed to emphasize maintenance as a separate discipline instead of ignoring it or lumping it in together with systems development. These macro ideas could be promoted through computer societies, SIGs, associations and curriculums.

6. CONCLUSIONS

The findings from the study generally suggest that Singapore IS professionals' perceptions of maintenance are more adverse than was previously thought. The root cause appears to be the massive on–going computerization in Singapore that tends to lure IS professionals to better paying and more visible development jobs, much to the detriment of the maintenance function. The situation is further exacerbated, firstly, by some organizations adopting inappropriate personnel practices that lead to low morale among the maintenance staff and, secondly, by the tendency of the younger IS staff to change jobs in their eagerness to forge ahead in their careers.

The undesirability with which Singapore IS professionals view maintenance could persist, or even worsen, if the current demand for new systems continues to produce a tight labour market for development personnel. Nonetheless, IT policy–makers, corporations and institutions in Singapore can help to alleviate the problem by adopting some of the corrective steps previously proposed by other software maintenance researchers and summarized in this paper. These include, in an IS organization, according equal status to maintenance and development, equal monetary rewards and comparable compensation, and better defined career paths. Tertiary institutions in educating new entrants could place emphasis on the challenges as well as the importance of software maintenance.

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